Drone Surveillance in Flood Affected Areas using Firefly Algorithm

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***Abstract*— Floods are the most common natural disaster. This is because the climate is changing a lot and there aren't enough dams. Every year, floods cause a lot of damage to people, animals, and property. The first 72 hours after a disaster are the most important and life-threatening. This means that rescue efforts must start right away and move quickly. For these responses to work, the information needs to be correct and up-to-date, which can only happen with good communication and management between the victims and the different people involved in the response. Due to the collapse of physical infrastructures, old ways of communicating become useless and movement on the ground almost stops. Because there aren't any roads or other ways to get around, it's hard to do rescue work on the ground. Drones, on the other hand, can easily get to places where roads have been destroyed or stopped working. Drones with different skills should be part of the fleet helping with the rescue operation. This will make the efforts more successful. Most of the systems that were already out there in the literature had a central system for these drones. But as the number of tasks needed grows, the performance of the current system starts to get worse. This research is based on the idea that a smart method for relief operations done by multiple drones is more effective than a centralized method. In this proposed work, we have done a drone surveillance for the flood affected area by using Euclidean distances between the places to visit. The optimal path needs to be found out and, in this approach, we have made use of the Firefly Algorithm. The results are observed and listed to prove the efficacy of the proposed model.**

Keywords—Drones, Surveillance, Flood-hit, Firefly Algorithm, Euclidean Distances.

I. INTRODUCTION

Every year, typhoons and severe rains generate devastating floods across the world. As an example, in January 2020, torrential rains slammed southeastern Brazil, killing 44 people and injuring 13,000 more. Southeast Texas and southwest Louisiana are both devastated by Hurricane Harvey this year. A staggering USD 25 billion has been lost as a result of flooding-related housing losses. Global climate change is anticipated to increase the frequency and severity of floods. Thus, an automated method for detecting and analyzing the damage caused by such calamities is essential.

A timely reaction and efficient distribution of limited resources, such as rescue teams, disaster supply kit distribution, and restricted supplies, reduces the danger of human deaths. In regions prone to flooding, such as rivers, sensors can be put to measure the water level. Sensor-based systems, such as, have been proposed to measure pressure, bubbles, floating, and other properties, such as density and volume. The restricted area covered by fixed sensors and the expensive expense of installing and maintaining a large number of dispersed sensors, however, limit their real-world applicability.

Light-weight airborne remote sensing platforms with high spatial resolution and unprecedented operational flexibility are possible thanks to recent advances in miniature flight control, propulsion, and light-weight airframe technologies, as well as the continuing trend toward miniaturized imaging sensors. The first successful UAV flight may have taken place as early as 1849, when Austrians launched 200 pilotless balloons against the city of Venice, however this is not confirmed. A wide range of uses for drones have emerged over the past few decades, and they've gained a lot of traction in the aviation industry as a whole [1]. The drones are thought to perform the risky, dull, filthy, or unintelligent duties. Disaster management, geographical monitoring, journalism, precision farming, archaeology and pizza delivery are all examples of how drones may be employed in a wide range of fields [2].

Compared to human aerial vehicles, UAVs are a more cost-effective option. For a number of applications, numerous unmanned aerial vehicles drones are needed to carry out effective joint operations. Depending on the model, UAVs can have a wide range of aerodynamic models [3]. An aerodynamics fault in a UAV mission puts the operation's cost, secrecy, and success at risk, making UAV design and functionality more difficult and expensive. As a result, it is essential to conduct a thorough test on a test bed or simulator that complies with the viability criteria of drones before making them operational. We'll be using the terms "UAVs" and "drones" interchangeably throughout this document. Fig. 1 depicts the use of drones over a disaster hit area.

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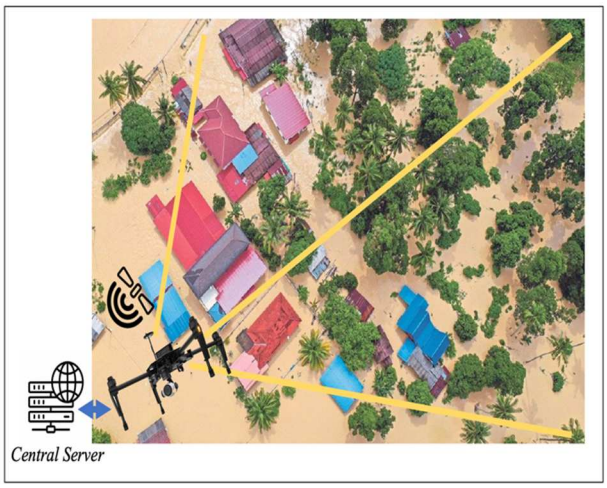

Fig. 1. Use of Drones in Flood affected Areas

Recent technical breakthroughs have made it possible to conduct search and rescue (SAR) without the need for human intervention [4]. Increase the number of people saved from a tragedy by using computer vision and a drone monitoring system. However, the employment of a drone to save someone's life is innovative and a wonderful cause, despite the mixed reaction to previous drone activity. When it comes to search and rescue (SAR), drones are becoming increasingly popular [5]. Drones are also being used by police and fire services to aid in time-sensitive rescue missions. Using a drone to survey the damaged region and identify the precise locations where aid is needed is the notion behind drone-surveillance in search and rescue [6]. Fig. 1 depicts a surveillance and search activity that is automated. Following the identification of a person's position, the rescue team can provide the person's GPS location to the rescue team for a speedy and efficient rescue.

In this paper we have made use of Firefly algorithm for finding the path of the drone in flood affected areas. The experimental results are observed to prove the efficiency of the algorithm. The following sections will discuss on the various state-of-art techniques, the proposed methodology and the experimental results obtained.

II. Related Works

Drones have been used in large-scale catastrophes, there is no conclusive evidence to support this claim [7]. Current drone feasibility projects are being evaluated in this article, as are a number of issues linked to the use of drones in catastrophe situations. There are four types of drone use in disasters: (1) mapping or disaster management, which has demonstrated the greatest benefit; (2) search and rescue; (3) transportation; (4) training. An inventory replenishment and replenishment of the stochastic scheduling, allocation, and scheduling issue [8] is modelled using a finite horizon Markov decision process.

Making this a reality has been a goal of the Human-Drone Interaction community since its founding in 2011 [9]. We lack a high-level view of the present and future uses of drones, despite some important results. A total of 16 areas and over 100 applications have been found in which drones and humans interact. As a follow-up, we provide a number of previously unrecognized use cases that have the potential to be transformative. Using drones to deliver Internet connection to remote areas where terrestrial BSs [10] are not practical is one option. Drone-assisted wireless network service must overcome a number of significant hurdles despite their many benefits. We've compiled a step-by-step guide on optimizing Drone-BS locations in 3D space in this post. There are several ways that the Internet of Drones (IoD), which includes smart city monitoring, might improve the quality of everyday living. The Internet of Things (IoT) is vulnerable to a wide range of attacks, some of which have never before been seen. An IoD [11] application scenario security solution was suggested and claimed to be secure by Wazid et al. However, their system is vulnerable to theft of verifiers and tracking devices. Then, a new plan is offered to address these flaws.

In this study [12], we provide a radio-frequency (RF)-based surveillance system that uses a high-performance convolutional neural network to identify and categories drones and recognize activities. Network size and computational costs may be drastically reduced by using the suggested RF-UAVNet network, which is designed using grouped one-dimensional convolution. In addition, a unique multi-level skip-connection structure has been presented to maintain gradient flow and achieve high accuracy by improving learning efficiency. Many authorities are concerned about the worldwide increase in traffic. The most recent and widely used DL object identification models are used in this article to demonstrate the unique aerial picture traffic monitoring and surveillance methods. Ground-view photos are not adequate for aerial object recognition, according to this study's findings. YOLOv4 [13] surpasses the other established models by a margin of 88 percent, according to extensive experimentation.

In a smart city [14], inhabitants may expect dependable e-services, a better quality of life, and everyday attention to their requirements. Developing smart cities throughout the nation is a key aspect of India's ambitious "Digital India 2030" strategy, which was announced in 2014. There is a tremendous quantity of data generated by residents in smart cities every day that might be used to improve the quality of life in these communities. UAVS photogrammetry and artificial intelligence (AI) [15] will be tested to see whether they can be used to control natural disaster damage in Korea. We were able to assess damage information such as destroyed infrastructure or the traces of soil erosion surrounding the river flood and reservoir collapse region using an ortho-image map with a resolution of less than 5cm made from aerial images taken by UAVs at an altitude of 100m250m. Research [16] in this field is focused on determining the best way to maximize drone coverage after a flood. Drones are increasingly being used in modern disaster relief efforts, particularly in the event of floods, to document the damage and draw up evacuation plans for those affected. Inertia, exploration, exploitation, velocity, and the height of the drones may all be determined using this method, which has shown outcomes.

As a technique for visualizing digital twins of cities, augmented reality (AR) [17] has gained a lot of interest. In the event of a natural catastrophe, this technology may provide an aerial and first-person view of the affected region, as well as a bird's-eye view from a distance of several hundred feet. Verification and case studies are used to illustrate the system's usefulness. For disaster response in cities, this research intends to identify the technical and regulatory elements of drone application and to offer a strategic framework for optimizing drone capabilities in cities. Actions, internal

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organization, external environment, requirements definition, and feasibility study are all included in the framework for using drone technology in disasters [18]. Harmonization Triangle shows how stakeholders need to work together in order for the framework to be successful. They're both meta-heuristic algorithms that may be used to solve searching and optimization challenges [19]. The Lévy flight property of the proposed IQFACS algorithm is more successful than quantum principles in escaping the QFA's early convergence and stagnation stage. Path planning on satellite pictures with vegetation as the target zone is possible thanks to the method that has been developed.

The Stepping-Ahead Firefly Algorithm was used by researchers at the University of British Columbia in Canada to examine challenges with robot route planning based on landmarks (SAFA) [20]. Researchers were interested in finding the optimum method for picking landmarks as waypoints so that the convergence time and route length are as short as possible. SAFA and the equation of motion were also successfully used to tackle the issue of robot motion planning in the research. The most important component of mobile robot route planning is the choosing of an algorithm. Genetic algorithm (GA), ant colony algorithm (ACA) [21], and firefly algorithm (FFA) are the most often utilized algorithms for route planning at the moment (FA). A drawback of FA is that it is easy to become stuck in a single optimum solution. In this article, a hybrid method based on GA and FA is proposed. Processes based on data must make room for AI-driven frameworks [22]. The development of technology is focused on reducing the amount of data that must be transmitted and the amount of network traffic that must be handled [23].

III. METHODS

The major objective of this proposed research work is to traverse the flood affected areas in minimal tie. This is because the search and rescue operations need to be carried out very fast in such disaster hit time. To overcome this challenge we have proposed a model based on Firefly algorithm. The overall workflow of the proposed method is depicted in Fig. 2. From the workflow we can see that initially we need to identify the places over which the drone needs to hover. If a flood has affected a city, it is not possible that the entire city is flooded. The coastal areas would be flooded to an extent and they would need a immediate rescue and recovery operations to be done. So first the geographic area is considered. The sample study area taken in this research work is as shown in the Fig. 3. Once the geographic area is taken into consideration we need to identify the places through which the drone need to fly. It could be any street or any particular building. The identification of places to visit is taken as assumption and is plotted in Fig. 4. Once the places are identified now we can pose this problem as a Travelling Salesperson problem(TSP). The idea here is to cover all the places in minimum time and distance. To get that solution we need to initially obtain the distance matrix. while obtaining the distance matrix, we obtain a complete graph. A complete graph gives the connection between any two places in a graph. The depiction of complete graph is depicted in Fig. 5.

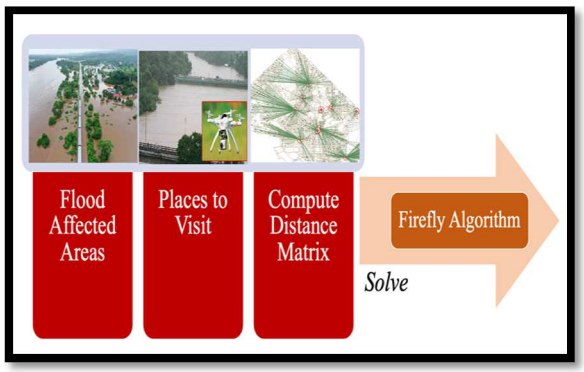

Fig. 2. Overall Workflow

Fig. 3. Geographic Area

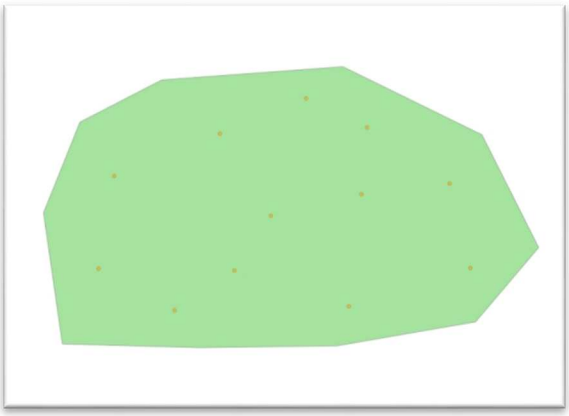

Fig. 4. Places to visit

Once the problem is posed as TSP, we try to solve it using Firefly algorithm. The experimental results obtained while using this particular algorithm is discussed in the subsequent section.

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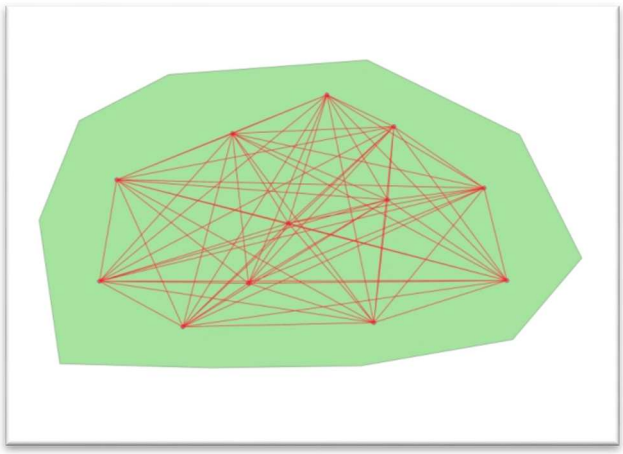

Fig. 5. Complete Graph

IV. Results And Discussion

The experimental results for the proposed research work were carried by making use of the QGIS 3.10.0 with GRASS 7.8.0. Initially the geographic area is considered and within that area, we need to find the places of visit. The coordinates of the places that needs to be visited by the drone is tabulated in Table 1. Once the coordinates are obtained, we form a complete graph such that there is distance between any two places from the geographic area. The complete graph for the geographic area taken is shown in Fig. 6. Once the complete graph is computed, we obtain the distance matrix. This matrix gives the distance between any two places. A sample distance matrix is as shown in Table 2. The total number of edges in the distance matrix is equal to 66 and the total distance is 128279069mm.

TABLE I. Place Coordinates

id	xcoord	ycoord
1	80.24356	13.03757
2	80.24767	13.03917
3	80.25102	13.04051
4	80.2534	13.03941
5	80.2566	13.03729
6	80.25318	13.03688
7	80.24965	13.03607
8	80.24823	13.034
9	80.24591	13.0325
10	80.25269	13.03264
11	80.25741	13.03409
12	80.24295	13.03407

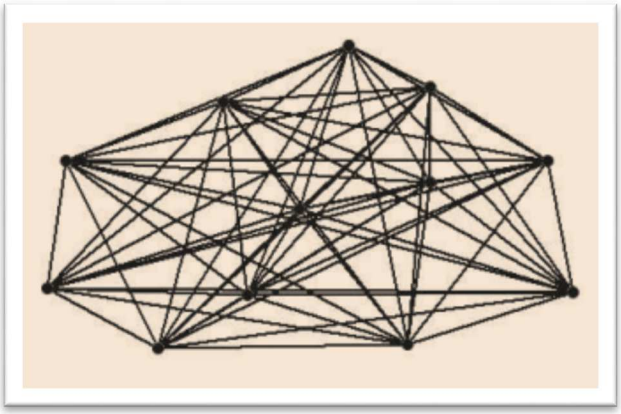

Fig. 6. Complete graph - Implementation

TABLE II. Distance Matrix

InputID	TargetID	Distance
1	2	0.00441
1	3	0.008018
1	4	0.010006
1	5	0.013044
1	6	0.00964
1	7	0.006275
1	8	0.005884
1	9	0.005594
1	10	0.010375
1	11	0.014279
1	12	0.003557
2	1	0.00441
2	3	0.003608
2	4	0.00573
2	5	0.009127
2	6	0.005962
2	7	0.003678
2	8	0.005203
2	9	0.006903
2	10	0.008235
2	11	0.010982
2	12	0.006951

Once the distance matrix is computed we now pose the problem as TSP. The TSP can be solved using various algorithms. There are lot of evolutionary algorithms, deep learning-based algorithms and even machine learning based algorithms to solve it. In this paper, we have considered using the Firefly algorithm due to its ease of implementation over other algorithms. The results were observed while making use of the firefly algorithm and the optimal solution was found as shown in Fig. 7.

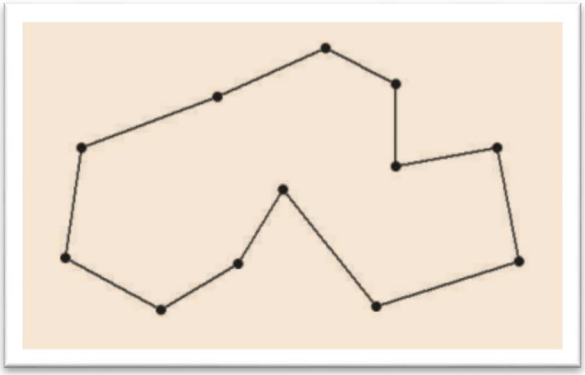

Fig. 7. Solving TSP using Firefly Algorithm

V. Conclusions

Most floods are brought on by heavy rain, and as a result, their occurrence may be foreseen to some degree. It is typical for a flood to take days to form, giving communities time to prepare and implement evacuation procedures. The so-called flash floods, which are exceedingly dangerous and impossible to anticipate, occur less frequently. During these events, a calm river can quickly change into a flood, carrying debris and rubble with it as it flows downstream. It's hard to say how much human activity contributes to severe weather. The importance of flood-specific automatic disaster management systems has been brought to light in this study. The water level contributes significantly to the analysis of the situation and the development of effective and efficient emergency response strategies. Aerial top-view photos, which are readily available thanks to current drone technology, are used in the proposed

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system to learn how to identify the water level. It uses a common definition of submerged items to determine the water level, specifically. In this paper, we have considered using drones for surveillance purposed of monitoring flood affected areas. They problem is posed as TSP and we have considered using the Firefly algorithm for the same. The specific contributions of the proposed work is the reduction in the total travel distance and execution time. The future work could consider the usage of multiple drones and also consider including the static and dynamic obstacles.

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